Section IV

Ecological Stewardship and Water Resources Management

Overview

Ecological stewardship refers to the thoughtful care of the ecological systems to preserve the natural qualities and character that are fundamental to the park's intrinsic values.

Ecological stewardship refers to the thoughtful care of the ecological systems to preserve the natural qualities and character that are fundamental to the park's intrinsic values as a place of natural beauty and respite from the built environment. For the long-term ecological health of the park, a well-defined, ongoing stewardship plan will be required. Although Dakota County has already established some restoration programs, the magnitude of the natural resource restoration work that is required to preserve the natural qualities that still exist and reintroduce those once found in the park is profoundly greater than what has occurred in the past. Simply stated, lacking a long-term commitment to ecological stewardship will undoubtedly result in a continuous decline in the ecological diversity and vitality of the park.

The forthcoming stewardship plan provides a framework for restoring and managing the natural resources within Lebanon Hills Regional Park. The plan relies heavily on human intervention as a surrogate for the natural cycles that no longer exist due to past human use of the land, introduction of invasive alien plants, and cessation of natural phenomenon (e.g., fire) since settlement first occurred. The plan also articulates a vision for water resources management that will best serve the park while at the same time addressing ongoing stormwater management issues.

Integration with the Comprehensive Natural Resources Management Plan

Note that the stewardship plan presented here complements the Natural Resources Plan that Dakota County developed in 2000. The Natural Resources Plan creates a broad vision for all of the regional parks within the County. The objective with the stewardship plan presented here is to take that vision one step further toward implementation.

Achievability and Sustainability of Ecological Stewardship Programs

It is important to recognize that restoring and managing ecological resources must be done in a manner that is both achievable and sustainable.

It is important to recognize that restoring and managing ecological resources must be done in a manner that is both achievable and sustainable. Achievable refers to what is scientifically *and* economically feasible. Sustainable refers to the level to which restoration and management programs can be scientifically *and* economically sustained over an extended period of time. The following considers achievability and sustainability from the two distinct but interrelated perspectives of ecology and economy (human/economic capital).

Ecological Perspective

From an ecological perspective, what is achievable and sustainable is defined in scientific terms based on testing and research. Scientifically, human intervention through well thought-out programs that are carefully implemented over a period of time can help to reverse the current downward trend in the ecological quality of the park's natural systems (as measured by biodiversity and general ecological health).

A successful program requires a full understanding of the ecological problems being faced and a defined course of action that is based on science.

A successful program requires a full understanding of the ecological problems being faced and a defined course of action that is based on science. As defined in this section, human intervention will be required to simply avoid the continued degradation of ecological systems found within the park. As also defined, the opportunity for reversing the current trend is quite broad and will vary widely depending on the particular ecological circumstance. In some systems, dramatic improvements in ecological quality can be made. In others, more limited expectations are warranted given the past impacts to them.

Although dramatic improvements can be made in some cases, restoring the landscape to pre-settlement conditions is not realistic from a scientific perspective. Past impacts to the land since man first settled and introduction of invasive alien plants simply preclude this possibility. However, it is achievable to restore and manage ecosystems to sustainable and productive levels that result in considerable human and ecological value and that can be perpetuated for generations to come. The key point here is that Dakota County and the community must set realistic goals and expectations as to what can be achieved through restoration and management programs.

Economic (Human/Economic Capital) Perspective

From an economic perspective, what is achievable and sustainable is based on the amount of human and economic capital that Dakota County (and the community) chooses to and/or can realistically afford to put into ecological programs now and in the future.

From an economic perspective, what is achievable and sustainable is based on the amount of human and economic capital that Dakota County (and the community) chooses to and/or can realistically afford to put into ecological programs now and in the future. The importance of this cannot be overstated in that the long-term viability of any ecological program undertaken is directly related to the long-term commitment made to it in terms of human and economic resources. This commitment can be viewed in the same context as commitments made to more common public infrastructural features such as schools and public utilities. Ultimately, how the collective community values land stewardship and ecological health relative to other quality of life issues will define the extent to which ecological programs can be successfully implemented. Gaining this commitment from the community will likely take time. Importantly, the timing of ecological restoration and management programs must be synchronized with the community's commitment if long-term success is to be assured. Recognizing this, it is critical that Dakota County time ecological programs in a pragmatic and paced manner that keeps pace with available resources. As discussed in this section, the first steps toward creating a sustainable local ecology include:

- Focusing on educational and public information programs to help residents better understand the issues and build a base of support for ecological programs.
- Undertaking testing and initial restoration projects to develop scientific underpinnings and experience.
- Enhancing human access of natural areas to encourage first-hand experiences and understanding of the local ecology.

Once the broader community better understands and shows support for and commitment to ecological stewardship programs, an increasingly robust effort can be put into implementing these programs.

Spectrum of Opportunity for Restoration of Ecological Systems

Without human intervention and conscientious ecological stewardship, it is expected that the overall trend of the ecological systems within the park will continue to decline, as measured by bio-diversity and general ecological health. Figure 4.1 graphically illustrates the ecological trend in a typical historic oak savanna system found in this and many other midwestern regions. This example is reflective of the type of trends that are apparent to varying degrees in virtually all of the ecological systems found within the park. Figure 4.2 graphically illustrates the current overall trend in ecological quality. It also defines the spectrum of opportunity for reversing this trend.

Figure 4.1 – Ecological Trend in Typical Oak Savanna System

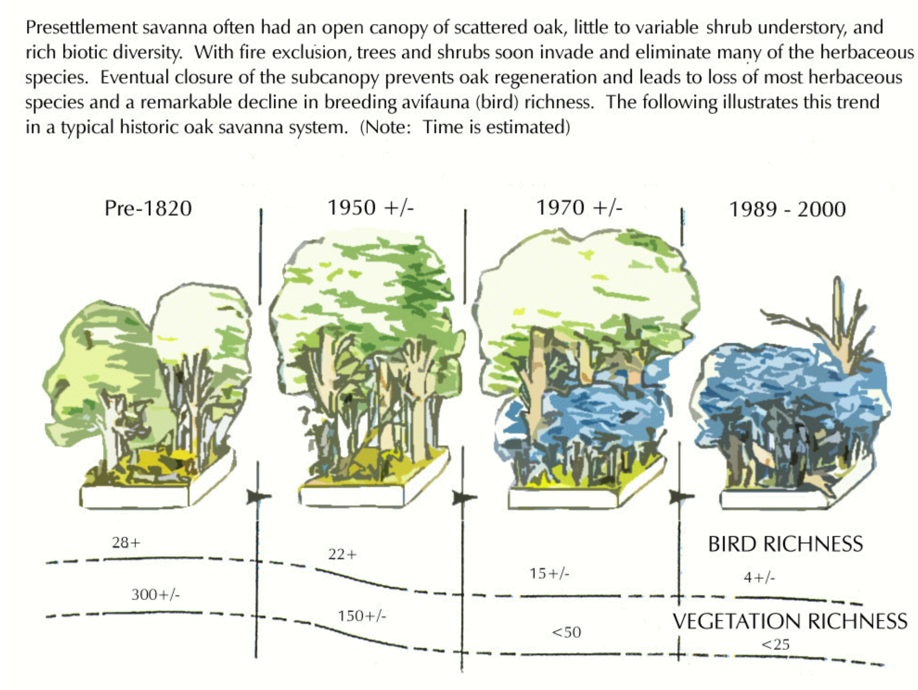
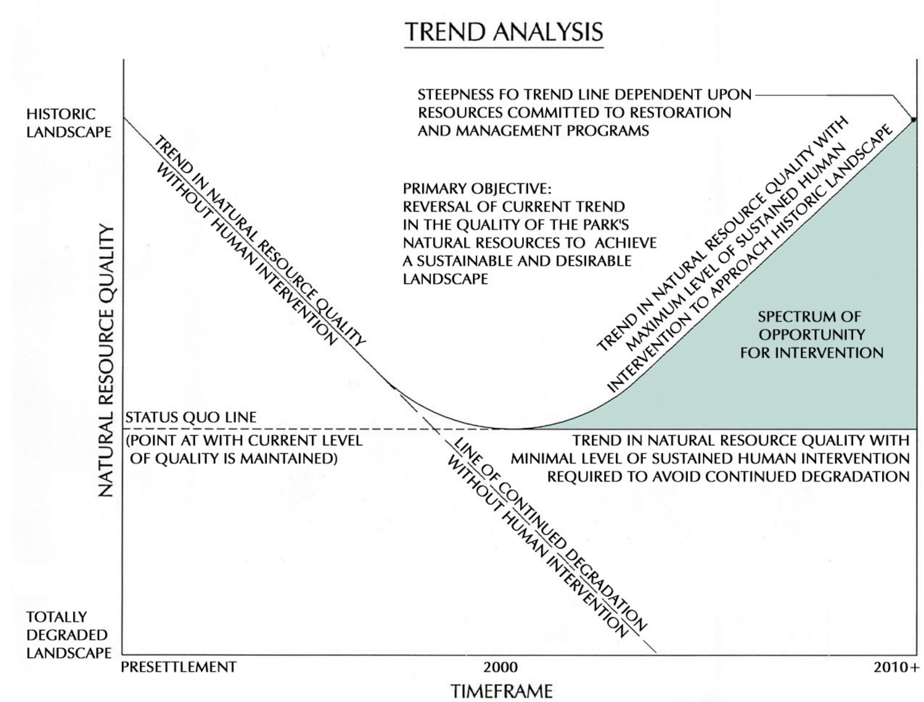


Figure 4.2 - Trend Analysis



The goal of the stewardship program is to identify restoration and management needs in scientific terms and define strategies that can reverse these trends.

The impact of human activities since settlement coupled with the curtailment of naturally-occurring events (wildfires) have served to change the ecological balance and character of the park. Some of these impacts will have lasting affects, while others can be addressed to forestall further degradation and help ensure a sustainable and healthy landscape for future generations. Given this reality, the goal of the stewardship program is to identify restoration and management needs in scientific terms and define strategies that can reverse these trends. The spectrum of opportunity for doing so is quite broad. At a minimum, a certain amount of human intervention will be required to simply avoid continued degradation. At the other end of the spectrum, achieving a historic landscape quality can perhaps be approached in some cases – although it is unrealistic to expect that a pre-settlement landscape can be replicated given the impacts to the land and water over the years since settlement occurred, along with the continued introduction of non-native plants into the park.

The framework presented here suggests that Dakota County Parks seek to achieve a sustainable landscape quality.

The framework presented here suggests that Dakota County seek to achieve a sustainable landscape quality, which is defined as the point at which the park district can indefinitely maintain a certain acceptable level of resource quality within the context of realistic limits. This sustainable level is contingent upon two primary factors:

- Public understanding of and commitment to land preservation and stewardship programs.
- Undertaking ecological restoration and management programs that are scientifically sound.

Individual and community values, policy-maker support, and financial resource commitment will ultimately define the extent to which restoration and management programs are implemented within the park.

Rationale for Implementing Stewardship Programs

The overall trend in ecological quality provides its own rationale for taking action.

The overall trend in ecological quality provides its own rationale for taking action. Analysis of the park's ecological systems makes it clear that the long-term prospects for preserving the quality of its natural resources is suspect unless appropriate measures are taken in the relatively near future. Further, the decline of the vegetative systems will likely be followed closely by reductions in the richness of wildlife species and the health and viability of other organisms in the ecological system. Scientifically, there are many specific reasons for taking action. Some of the more compelling ones include:

- Oak regeneration is not occurring and existing larger oaks are in serious decline.
- Animal and avian populations and richness are predicted to decline along with loss of natural habitat.
- Native plant species have experienced significant declines.
- Introduction and proliferation by non-native plant species represents a serious threat to soil, fauna, and native vegetation systems.
- Serious erosion problems are associated with the collapse of ground cover vegetation beneath the shade of introduced shrubs and pines. With this erosion, loss of soil seed banks, roots, and tubers is occurring.

A less scientific but equally compelling reason to take action is that citizens in this region have an expectation that the natural resources that surround them will remain healthy and ecologically viable and that responsible land stewardship will remain at the forefront of discussions, debate, and, most importantly, action.

Ecological Stewardship Philosophy

The plan outlined here promotes an ecological system-based approach to restoration and management.

The plan outlined here promotes an ecological system-based approach to restoration and management. An ecosystem is essentially where things live and represents an interacting group of physical elements (soils, water, plants, animals, and human communities, etc.) that inhabit a particular place. All of these elements and their interactions need to be considered in developing goals and plans for management. Ecosystem-based management views people as part of the community, and that maintaining a healthy ecosystem is the best way to meet human needs as well as those of other organisms in the community. General goals of this philosophy are to:

- Protect or enhance the health of the ecosystems in Lebanon Hills Regional Park.
- Enhance the biological diversity of its native habitats.
- Provide an appropriate balance between resource preservation and recreational use.
- Maintain the natural and historic integrity of the park.
- Establish partnerships and stakeholder involvement with a variety of agencies and citizens in the community to perpetuate sustainable ecological systems in the park (and surrounding areas affecting the park).

Through a well-defined stewardship program, a concerted, ongoing effort by Dakota County, and an extensive public education campaign, a certain level of confidence can be gained that the current ecological trends can be reversed and a more sustainable and higher quality landscape achieved.

Philosophical Underpinning

The restoration philosophy for all projects should focus on creating and restoring ecological systems as efficiently and effectively as possible.

The philosophical basis of this plan is heavily reliant on careful and efficient implementation of restoration and management programs. This philosophy focuses on creating ecologically valuable biological communities within the context of a disturbed landscape. The initial analysis of the park provides some fundamental information that serves as a baseline for developing a comprehensive plan and assessing the effectiveness of those plans. Restoration of the structure and function of ecological systems to an achievable and sustainable level is being used here as a definition for improving environmental quality. The assumption is that if the structure and function of ecological systems are restored, then wildlife opportunities and human enjoyment benefits will also be realized. The restoration philosophy for all projects should focus on creating and restoring ecological systems as efficiently and effectively as possible. It should not be the intent to slavishly recreate landscapes that were present 150 years ago. Some changes in the landscape and existing conditions simply preclude these opportunities. Therefore, it should not be a goal of this program to burden the residents of the region with a stewardship program that would be neither practical nor achievable. The key goal is to establish a program that reverses the current downward trend in the quality of the park's natural resources and achieve a sustainable landscape quality that can be indefinitely perpetuated.

Adaptive Management

Management plans need to be flexible due to the changing nature of the ecological systems addressed by the plan.

Management plans need to be flexible due to the changing nature of the ecological systems addressed by the plan. Plans also change over time in response to new data and derived insights unique to any given site. For these reasons, the framework presented here should be viewed as being neither conclusive nor absolute. It is a starting point in an ongoing process that relies on monitoring to provide feedback on program effectiveness and for evaluation of the need for any changes in approach. This process of evaluation, adjustment, refinement and change is *adaptive management* and is fundamental to future management, maintenance, and restoration of the ecological system within the park.

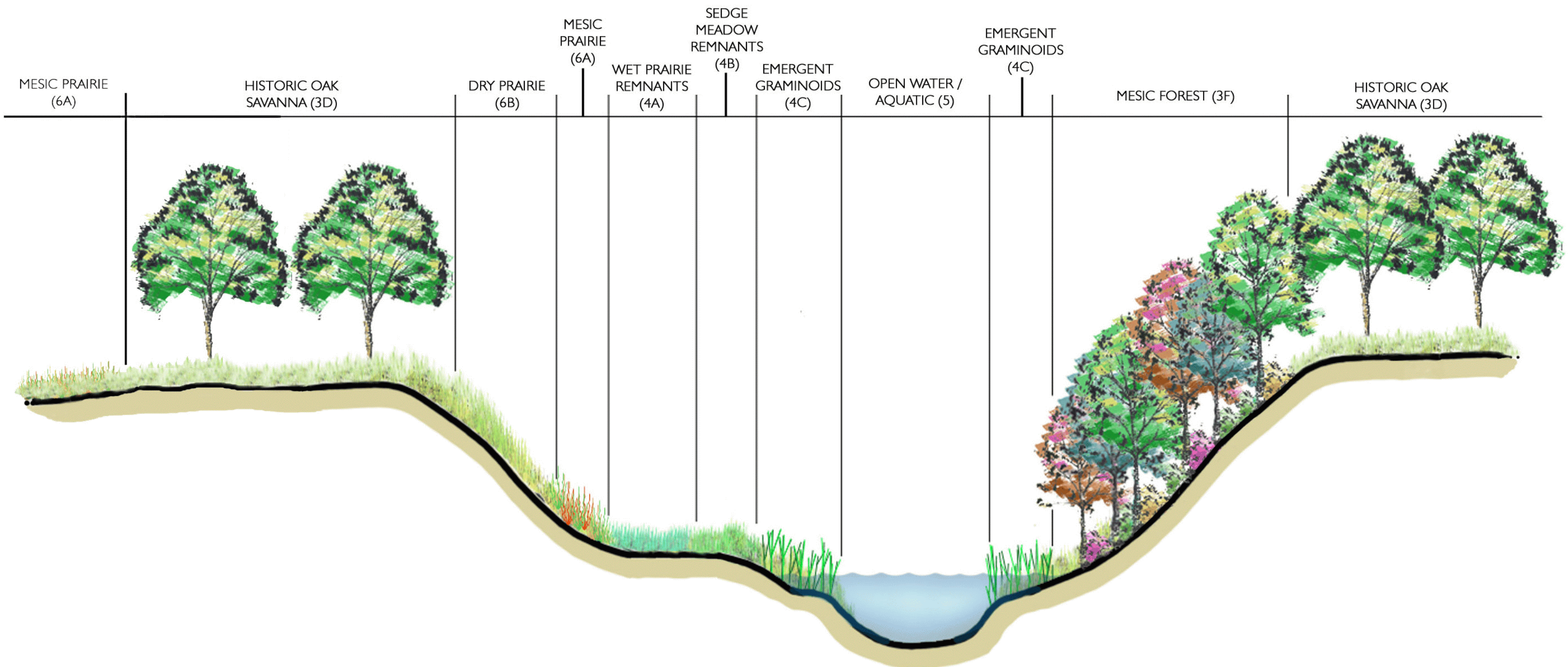
Ecological Prototypes for Unaltered and Altered Ecological Systems

In this context, ecological prototypes refer to vegetative species models for the various ecological systems. The presence, or lack thereof, of certain compositions of species within each prototype aids in defining the ecological health of that system. These indicators found within a given area of field investigation give clear guidance on whether or not the ecological system has been altered or degraded. This in turn aids in determining the best approach to restoring and managing that system.

Ecological prototypes are defined along topographic, soil type and hydrological gradients from high-dry uplands to lowlands and wetlands.

Ecological prototypes are defined along topographic, soil type and hydrological gradients from high-dry uplands to lowlands and wetlands. Based on an initial review of the park, both unaltered and altered ecological prototypes can be found. In unaltered areas, depending on soil types and hydrology, different plant and animal communities have developed over long periods of time and have persisted even to present day under less than ideal circumstances. On these same soil types, alteration of hydrology through land drainage, wetland or lake margin filling, and damming/impounding water along with cessation of natural processes have created changes in the plant (and animal) communities. Each of the unaltered and altered types of plant and animal communities fall within a definable ecological prototype. The following descriptions define some of the *typical* prototypes for healthy (unaltered) and unhealthy (disturbed) ecological systems found within the park. Figure 4.3 provides a character sketch of how these selected prototypes relate to each other.

Figure 4.3 – Relationship between selected prototypes.



Lacking greater technical evaluation and in-depth research, the prototypes presented here serve to underscore the conditions being faced within the park. They also serve as a starting point for refining the prototypes as Dakota County moves forward with its stewardship program. Although these prototypes are not exhaustive, they do articulate the fundamental qualities between healthy and unhealthy ecological systems found within the park.

Importance of Prototypes

By recognizing what a healthy ecological system looks like, specific targets or models for management and restoration programs can be developed and implemented.

Prototypes assist restoration and management efforts by helping compare existing conditions against measurable criteria for healthy ecological systems and in recognizing possible causative agents that result in ecological changes. Once these baseline comparative analyzes are completed, restoration and management strategies and cost projections can be made to address existing conditions. By recognizing what a healthy ecological system looks like, specific targets or models for management and restoration programs can be developed and implemented. Monitoring the progress of these programs can be followed using data that measures shifts in prototypes.

Historic Oak Savanna (3D)

Healthy Systems

General Structure
- Semi-open to open tree canopy
- Multiple age classes of trees
- Dominant cover of native grasses, sedges, and forbs
- Natural oak regeneration
- Sporadic native shrub layer
- High light levels interspersed with partial/isolated shade

Soils Profile/Topography/Hydrology
- Well drained silt, clay and sand loams, gravelly sands, alluvium glacial features
- Higher and dry sites, and moist, well drained soils

Indicator Species of Healthy System
- Bur oak
- Northern pin oak
- White oak
- Savanna groundlayer species

Associated Species
- Pennsylvania sedge
- Silky and Virginia wild rye
- Bottlebrush grass
- Other sedges
- American hazel
- Little bluestem

Unhealthy Systems

General Structure
- Continuous, closed canopy
- Dense layer of non-native shrubs
- Bare, eroding soil
- Low light levels, predominant dense shade
- No oak regeneration
- Few or no young age classes of trees
- Lack of native groundcover vegetation
- Encroachment by development or agriculture

Indicator Species of Unhealthy System
- European buckthorn
- Tartarian honeysuckle
- Black locust
- Boxelder
- European brome, Kentucky bluegrass, and other non-native grasses
- Agricultural weed species and brambles

Protection and Management Considerations

Causes of Change
- Cessation of historic fire regimes
- Destruction due to urban development
- Invasion of competing non-native shrubs
- Encroachment of adjacent development with associated pollutants
- Intensive grazing
- Change in hydrologic regime (drier or wetter)

Restorative Capacity
- Highly restorable under well-designed and implemented restoration and management program
- Highly disturbed sites may require replanting of native species, especially ground cover, if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection beyond that of existing wetland ordinances
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Mesic Deciduous Forest (3F)

Healthy Systems

General Structure
- Mixed canopy of oaks, ash, maple, and basswood
- Predominated by cool season grass and sedge ground cover

Soils Profile/Topography/Hydrology
- Found in isolated or protected locations, steep draws, and on landscape islands
- Topography ranges from level ground to rolling and steep grades
- Loam and fine sandy loam

Indicator Species of Healthy System
- Red oak
- Basswood
- Sugar maple
- White ash
- Silky and Virginia wild rye
- Woodland sedges
- Spring wildflowers (trilliums and spring beauty)

Associated Species
- Sedges (*Carex blanda*, *Carex sprengelii*, etc.)
- Native grasses
- Shrubs, such as hazel and arrowwood

Unhealthy Systems

General Structure
- Shift to even canopy, with limited age groups of trees
- Dense understory
- Bare soil after spring ephemerals die back
- Noticeable soil erosion

Indicator Species of Unhealthy System
- Boxelder
- European buckthorn
- Canary grass
- Motherwort
- Thistles
- Burdock
- Rough bedstraw
- Stinging nettles

Protection and Management Considerations

Causes of Change
- Cessation of light ground fires
- Loss of seedbank and erosion
- Weed invasion
- Altered hydrology, whether drier or wetter
- Logging disruption of composition, structure, light, and nutrient regimes
- Livestock grazing causing weeds and tree damage

Restorative Capacity
- Highly restorable under well-designed and implemented restoration and management program
- Highly disturbed sites may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Upland Prairie Systems (6A and 6B)

Healthy Systems

General Structure

- High biodiversity – plants, insects, birds, and other animals
- High diversity of native plant species
- Predominance of warm-season grass species
- Natural succession and progression toward conservative species
- Full to nearly full sun
- Drought tolerant

Soils Profile/Topography/Hydrology

- Moderate to well drained, fine textured sands and sandy loams
- Higher and dry sites, most often associated with flat terraces or gentle slopes

Indicator Species of Healthy System

- Big bluestem
- Little bluestem
- Side-oats grama
- Purple prairie clover
- Leadplant
- Sky blue aster
- Prairie coreopsis
- Partridge pea
- Flowering spurge
- Blue giant hyssop
- Compass plant
- Prairie dock

Associated Species

- Literally hundreds of associated species

Unhealthy Systems

General Structure

- Low biodiversity – plants, insects, birds, other animals
- Predominance of weedy, non-native vegetation
- Absence of ecological functions
- Loss of water infiltration
- High soil erosion potential
- Invasion by woody species
- Nutrient enrichment
- Tile drained or ditched, resulting in altered hydrology

Indicator Species of Unhealthy System

- European brome and other non-native grasses
- Ragweed
- Mare's tail
- Queen Anne's lace
- Canada thistle
- Wild parsnip
- Woody species such as sumac, black cherry, boxelder, and Siberian elm

Protection and Management Considerations

Causes of Change

- Introduction of post settlement agriculture and livestock grazing
- Soil disturbance from urban development
- Cessation of periodic fire
- Invasion of competitive, non-native plants
- Change in hydrologic regime (wetter or drier)

Restorative Capacity

- Highly restorable under well-designed and implemented restoration and management program
- Highly disturbed sites may require replanting of native species if native seed bank is absent

Protection Strategy

- Adopt land development practices that place a high priority on ecological protection beyond that of existing wetland ordinances
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Wet Prairie Remnants (4A)

Healthy Systems

General Structure
- Patchy, patterned plant communities reflecting soil and hydrological gradients
- High biodiversity – plants, insects, birds, and animals
- High diversity of native grasses and forbs
- Predominance of native grass, sedge, and forb species of low, moist-to-wet soils
- Natural succession and progression toward conservative species
- High groundwater table and often groundwater-based hydrology
- Full to nearly full sun

Indicator Species of Healthy System
- Prairie cordgrass
- Canada bluejoint
- New England aster
- Virginia mountain-mint

Associated Species
- Extensive variety of other native grasses, sedges, and forbs

Soils Profile/Topography/Hydrology
- Shallow organic soils
- Soils are saturated in the spring and dry out as year progresses

Unhealthy Systems

General Structure
- Altered hydrology due to de-watering
- Heavy invasion by woody growth
- Invasion by non-native reed canary grass
- Homogenous vegetation and low pattern of diversity

Indicator Species of Unhealthy System
- Reed canary grass
- European buckthorn
- Glossy buckthorn
- Overstocked dogwoods
- Purple loosestrife
- Stinging nettles
- Redtop

Protection and Management Considerations

Causes of Change
- Draining of soils for agriculture tillage
- Cessation of wild fire and overgrazing
- Hydrologic changes due to urban development and a change to surface water rather than groundwater dependent hydrology
- Nutrient enrichment from dewatered substrates and offsite introduction
- Salt and fertilizer loading

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be controlled
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and storm water treatment trains
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Sedge Meadow Remnants(4B)

Healthy Systems

General Structure
- High biodiversity – plants, insects, birds, and animals
- High diversity of native sedges and forbs
- Domination by sedges, rushes, reeds and grasses

Soils Profile/Topography/Hydrology
- High groundwater table
- Shallow to moderate organic substrates

Indicator Species of Healthy System
- Tussock sedge
- Lake sedge
- Canada bluejoint
- Wool grass
- Marsh milkweed
- Swamp aster
- Sawtooth sunflower

Associated Species
- Swamp dock

Unhealthy Systems

General Structure
- Altered hydrology due to de-watering or too much water
- Heavy invasion by woody growth
- Invasion by non-native reed canary grass

Indicator Species of Unhealthy System
- Glossy buckthorn
- Reed canary grass
- Overstocked dogwoods
- Purple loosestrife

Protection and Management Considerations

Causes of Change
- Sediment, nutrient and contaminant loading from disturbed uplands
- Soil disturbance from development
- Cessation of periodic fire
- Invasion of competitive, non-native plants
- Change in hydrologic regime (wetter or drier)

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be controlled or mitigated
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and storm water treatment trains
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Forested Wetland – Bog Subtype (4E1)

Healthy Systems

General Structure
- Saturated acid peat soils
- Low nutrient content
- Unique assemblage of stunted trees, low shrubs and herbs growing on a mat of sphagnum mosses
- Predominance of herbs and low shrubs of the heath family (Ericacea)

Soils Profile/Topography/Hydrology
- Peat substrates of variable depth

Indicator Species of Healthy System
- Sphagnum mosses
- Tamarack
- Black spruce
- Bog sedges
- Leatherleaf
- Bog rosemary
- Small cranberry
- Pitcher plant

Associated Species
- A wide variety of associated species can be found in these systems

Unhealthy Systems

General Structure
- Dewatered peat soils
- Removal of peat substrates
- Shrub invasion
- Nutrient loaded

Indicator Species of Unhealthy System
- Cattail
- Shrub invasion by alder
- Purple loosestrife
- European buckthorn
- Glossy buchthorn

Protection and Management Considerations

Causes of Change
- Artificial dewatering
- Harvesting of sphagnum moss
- Harvesting of peat
- Conversion to commercial cranberry and wild rice production
- Use of bogs for wastewater treatment
- Cessation of fire
- Water enrichment and chemistry changes

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be mitigated
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent
- Restoration of bogs is slower than other systems

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and storm water treatment trains
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Emergent Graminoids (4C)

Healthy Systems

General Structure
- Shallow, open water communities
- Water depths less than 2 meters (6.6 feet)
- Emergent, submergent, floating and floating-leaved aquatic vegetation
- Presence of habitat and communities of waterfowl, amphibians, fish, furbearing mammals and invertebrates

Soils Profile/Topography/Hydrology
- Sand and gravels or shallow bedded organic matter

Indicator Species of Healthy System
- Bur-reed
- Arrowhead
- Bulrushes
- Water plantain
- Pondweeds
- Water lilies
- Coontail

Associated Species
- Various sedges and native shrubs

Unhealthy Systems

General Structure
- Sustained high water levels or drastic level changes
- Nutrient, sediment and toxic chemical loading from uplands and roadways
- Dominance by cattail, giant reed grass, and reed canary grass

Indicator Species of Unhealthy System
- Purple loosestrife
- Cattail
- Giant reed grass
- Reed canary grass
- Eurasian water milfoil
- Duckweed
-

Protection and Management Considerations

Causes of Change
- Increased runoff due to upland development
- Damming and impoundment of waters
- Industrial and agricultural runoff
- Nutrient enrichment

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be controlled or mitigated
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and storm water treatment trains
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Refinement of Ecological Prototypes

As part of the prototype refinement process, Dakota County Parks is encouraged to utilize the Minnesota Department of Natural Resources' Natural Community classification system where it has application as part of the stewardship program. This classification system, which is very extensive, is very useful for defining natural ecosystems (although it is a bit more limiting in addressing developed or agricultural systems). Whereas the classification system used for the master plan is easy for the lay person to understand and provided needed guidance for planning purposes, additional refinement using the MNDNR system has merit as the master plan moves from planning to implementation. Figure 4.4 compares the classification system used here against the MNDNR's system for reference.

Figure 4.4 – Land cover classification comparison.

Land Cover/Land Use Classification for Natural Resource Managemen
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Natural Resource Management Classification System	Potential MLCCS Numerical Correlates*
1 Developed Systems	10000, 20000
A Residential	13134 (typical), 210 (residential modifier)
B Commercial/Industrial	13144, 14113 (typical), 220 (commercial/industrial modifier)
C Recreational	240 (open space modifier)
D Railroad/road easement	230 (transportation modifier)
E Mowed lawn/landscaped trees/shrubs	20000
F Parking lots and other impervious surfaces	14123, 100 (100% impervious modifier)
2 Agricultural Systems	NC
A Farmstead/out building	13114, 13124 (typical), 260 (farm buildings modifier)
B Fields (cropped)	24000, 270 (agricultural field methods modifier)
1 Corn	24112
2 Beans	24111 (all types except soybeans), 24114 (soybeans)
3 Alfalfa	NC
4 Nursery (herbaceous)	23000
5 Oats	24212
6 Pasture	23000, 275 (pasture modifier)
7 Other (e.g., sod farm)	NC
C Fields (fallow)	23000, 24200
1 Unmowed	24216, 24227
2 Mowed	23000, 312 (mowed modifier)
3 Warm season grass plantings/prairie restoration	23000
D Bare Soil	14210

Notes: * MLCCS = Minnesota Land Cover Classification System, developed by the Minnesota Department of Natural Resources (curent as of 8/24/00).
Potential MLCCS numerical correlates are incorporated into this document for general comparisons between classification systems; however, it should be noted that direct correlation between classification systems is often not possible.
NC = no correlate identified or numerous possible correlates exist

Natural Resource Management Classification System	Potential MLCCS Numerical Correlates*
3 Forest Systems	30000, 40000
A Fence row (shrub/tree)	21000, 22000
B Lowland hardwood forest	32200
C Recently developed forest in degraded condition	32170, 42130
D Historic oak savanna	32110, 42120
E Plantation/orchard/nursery (woody)	21000
F Mesic forest	30000, 40000
4 Wetland Systems	NC
A Wet prairie remnants	61310, 61410
B Sedge meadow remnants	61320, 61420
C Cattail/tall emergent graminoids	61430, 61510, 61610, 61710, 61810
D Reed canary grass	412 (reed canary grass modifier)
E Forested Wetland	31200, 32300, 32400
1 Bog (saturated acid peat soils)	31210, 31220, 31230, 31240
2 Swamp (mineral soils)	32310, 32320, 32330, 32410, 32420
F Shrub thicket (willow/dogwood)	52200, 52300, 52400
5 Open Water/Drainage Systems	90000
A Lake	92000
B River	91000
C Stream/creek	91000
D Spring/seep	NC
E Detention/created pond	92000, 93000
F Farm ditch/canal	91000
G Aquatic (open water with submerged/floating vegetation)	93000
Upland Prairie Systems	61000
A Mesic prairie	61110, 61120
B Dry prairie	61210, 61220

Affect of Healthy and Unhealthy Ecological Systems on Wildlife

As would be expected, there is a marked affect on the species richness of wildlife when ecological systems become degraded.

As would be expected, there is a marked effect on the species richness of wildlife when ecological systems become degraded. What is perhaps not expected is the degree of decline that can entail. To illustrate this point, the two forthcoming tables define the decline of breeding bird species between healthy and unhealthy ecological systems.

Breeding Bird Species Associated with Healthy Ecological Systems

Prairie	Sedge Meadow	Emergent	Savanna	Lakes
Bobolink	Yellow warbler	Herons	Flicker	Terns
Blue bird	Willow fly catcher	Rails	Bluebird	Cormorant
Brown-headed cowbird	Yellow throat	Ducks, grebes	G. crested flycatcher	Mergansers
Grasshopper sparrow	Red winged blackbird	Swamp sparrow	Robin	Ducks
Vesper sparrow	Goldfinch	Red winged blackbird	Catbird	Grebes
Western meadow lark	Swamp sparrow	Sora rail	Cardinal	Coots
Song sparrow	Short/long billed marsh wren	Mallard	Blue jay	
Gold finch	Kingbird	Grackle	W. B. nuthatch	
King bird		Canada goose	Warbling vireo	
		Yellow headed blackbird		
		Kingbird		
20-30 species	**15-20 species**	**30-40 species**	**20-30 species**	**20-30 species**

Breeding Bird Species Associated with Unhealthy Ecological Systems

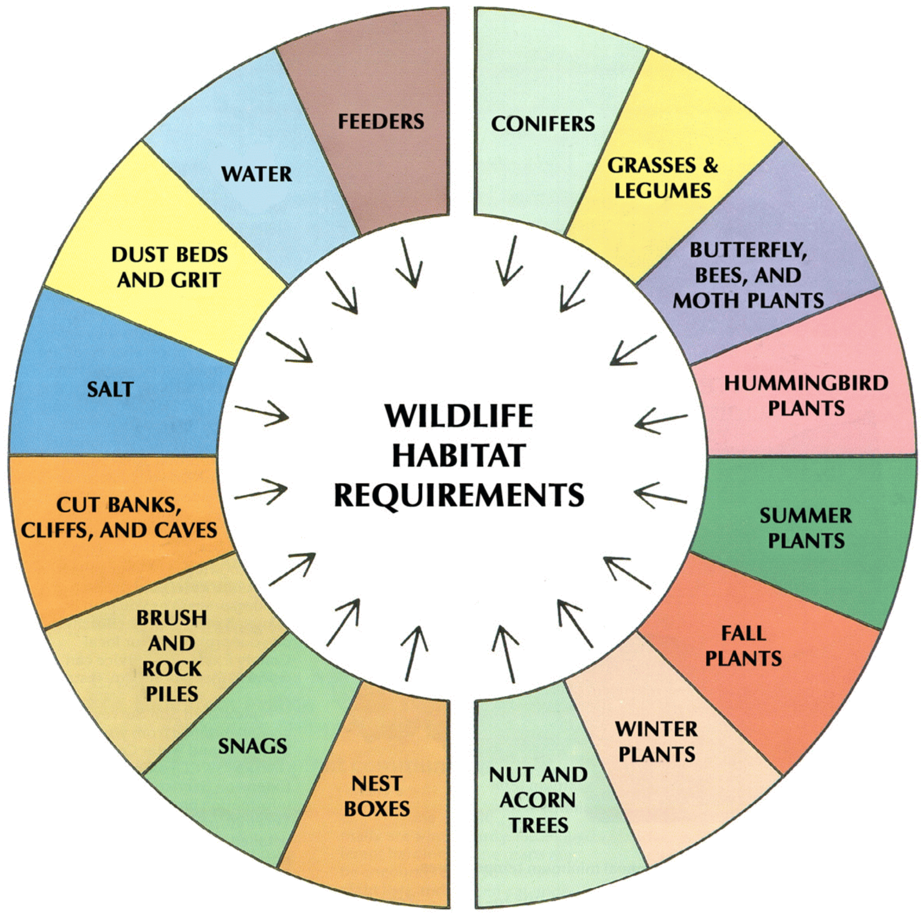
Corn Field	Cattail and Canary Grass	Degraded Savanna	Lakes
Horned lark	Red winged blackbird	Robin	Mallard
House sparrow	Mallard	Cardinal	Canada geese
	Canada geese	Starling	Coot
	Herons		
4-6 species	**15-30 species**	**5-10 species**	**5-10 species**

As the tables clearly illustrate, the decline in bird species can be quite steep as healthy ecological systems transition to unhealthy systems due to poor land use decisions and the lack of ongoing restoration and management programs.

When considering the needs of wildlife, healthy natural ecological systems provide the essential components for wildlife to flourish. Unhealthy systems, on the other hand, do not provide for the basic needs of wildlife because many of these components are lacking,. Figure 4.6 on the next page defines the essential components of wildlife habitat.

When these components are lacking or degraded relative to a healthy system, the diversity of wildlife found in the park will be diminished.

Figure 4.6 – Sixteen components of wildlife habitat. (Source: Landscaping for Wildlife, published by the MNDNR.)



When these components are lacking or degraded relative to a healthy system, the diversity of wildlife found in the park will diminish. While certain species of wildlife can flourish under degraded conditions, they do so at the expense of other species that once frequented the park.

Based on anecdotal evidence, sightings of less common wildlife species such as wild turkeys, coyotes, foxes, and birds of prey have increased in recent years. Given this, the park inherently has the potential to support a wide diversity of wildlife. By improving the ecological health of the park and ensuring that the wildlife habitat components as defined in figure 4.6 are provided, the long-term prospect for wildlife in the park is encouraging.

Ecological Stewardship Program Overview

The ecological stewardship program is relatively straightforward and consists of three primary phases.

The ecological stewardship program is relatively straightforward and consists of three primary phases. Each phase has distinct objectives toward the realization of more diverse and healthy ecological systems within the park. A phased approach also ensures that needed checks and balances are built into the process to ensure that program objectives being sought are proved to be both achievable and sustainable from an ecological and economic perspective.

The typical phases of the program includes:

- **Phase I: Testing and Education Phase** – broadens understanding of restoration needs, options, and opportunities. Also increases local residents' knowledge and understanding of restoration issues.
- **Phase II: Remedial Phase** – involves the major restoration and management tasks and consequently is usually the more expensive phase. Its focus is on returning the land to the biological and structural conditions desired and sustainable.
- **Phase III: Maintenance Phase** – represents the long-term management restoration program tasks associated with this project. This should be viewed as a routine maintenance program conducted annually at strategic times to achieve and maintain specific ecological and biological objectives in the subject properties.

The following considers these in greater detail.

Phase I - Testing and Education

Developing test plots and pilot programs and developing a comprehensive educational campaign are parallel first steps toward restoring balance to the park's ecological systems.

Developing test plots and pilot programs and developing a comprehensive educational campaign are parallel first steps toward restoring balance to the park's ecological systems. The former serves to help understand the needs, options, and opportunities for restoration and management of declining ecosystems within the park. The latter serves to increase local residents' and policy makers' knowledge and understanding of these issues and instill a sense of importance and urgency in undertaking stewardship programs. The following considers these issues in greater detail.

Testing and Pilot Programs

Small test or demonstration plots are the backbone of the initial testing program. Testing should occur in each ecological zone to test a cross-section of conditions found and to provide wider public exposure to the program. These tests will help determine which restoration practices are best suited for the setting. It is recommended that the testing scenarios be tested in small research plots within the park. A few may be tested in a greenhouse setting to control as many variables as possible. Plots can also be field located to provide an opportunity for testing multiple research possibilities.

There are a variety of testable scenarios and treatments that can be used. Selecting the most opportune of these would be done as the testing program is implemented. Likely test and demonstration plots encompass:

- Regeneration of oak forests -- to stimulate new growth.
- Reduction of shrub cover -- to increase light to the ground layer and stimulate growth.
- Reduction of cool season grasses (and associated duff) -- to stimulate native species soil seed banks.
- Reduction of noxious weeds and woody plants -- to give competitive edge to native plant species. instead of invasive, non-native plants (i.e., garlic mustard, buckthorn, tartarian honeysuckle, and reed canary grass).
- Reintroduction of ground cover plants and seed -- to reestablish native seeds.
- Establishment of native plant nurseries and gardens -- for educational purposes.
- Establishment of community outreach programs -- so residents establish a personal stake in the project.

Testing Standards

Standardized ecological field sampling methods are recommended for undertaking each of the programs. This ensures conformance with scientific standards and reliability of testing outcomes. Data is collected, analyzed, and used to set the parameters for full roll-out of the restoration and management plan throughout the park system.

Effect of Testing and Pilot Programs

There are a number of visible ecological impacts of the test plots that are worth highlighting, especially when prescribed burns are used. These include:

- Access into plot areas will be restricted for several hours during prescribed burning treatments.
- Site may appear burned for several days until grass green-up occurs if prescribed burning is conducted.
- After a short period of time, native and other rare plants will begin to benefit from prescribed burning.
- Overall aesthetics of the site will be improved as new growth asserts itself.
- Creation of healthy assemblies of native species will restrict further invasion by non-native species.
- Soils on the site will again be stabilized through the reintroduction of native plant species and the reduction of non-native ones that create dense shade.
- Water quality benefits will be realized with soil stabilization and nutrient entrapment.

Education Programs

Education plays a key role in the successful implementation of stewardship programs.

Education plays a key role in the successful implementation of stewardship programs. Although scientifically substantiated to vastly improve natural landscapes, implementing these programs will change the visible characteristics of the areas being restored. The public's understanding of what is happening becomes paramount to their support of complete implementation of stewardship programs. Although set up for research purposes, the testing and pilot programs also serve as in-the-field educational tools. Direct exposure to restoration practices and their impact on the surrounding environment will give park visitors working knowledge of stewardship programs. This approach sets the stage for Phases II and III of the restoration and management plan.

Phase II - Remedial Phase

The remedial phase focuses on returning the land to the biological and structural conditions desired and sustainable.

The remedial phase focuses on returning the land to the biological and structural conditions desired and sustainable. The period of time required to conduct the remedial restoration phase depends on the level of effort required, condition of the ecological systems, opportunities and constraints (e.g., access, weather, biological response), and level of funding available for the program.

The remedial phase employs a variety of restoration techniques in a major effort to restore vegetation and habitat structure and biological diversity and restore ecological and bio-geochemical functions. Tasks undertaken during this phase include reducing introduced nonnative and other undesirable trees and brush, removal of previous debris and substrate fill areas, addressing erosion and contamination problems, and other general tasks. In some cases, this phase may involve machine/mechanical planting of native plants, including larger trees and other plants.

Phase III - Maintenance Phase

The maintenance phase focuses on long-term management tasks, which must be viewed as a routine maintenance program conducted annually at strategic times to achieve and maintain specific ecological and biological objectives.

The maintenance phase focuses on long-term management tasks, which *must* be viewed as a routine maintenance program conducted annually at strategic times to achieve and maintain specific ecological and biological objectives. This phase will require an ongoing effort designed to achieve a desirable and sustainable ecological system within the context of available funding, other resources, and the public's commitment.

After significant investments in human energy and funding in Phase II, the stewardship program shifts to a lower level of intervention during the maintenance phase. This is inherently less costly and provides an excellent opportunity for long-term citizen and student involvement as volunteers.

Once established, the maintenance phase is guided by both regular management techniques and by strategies that are implemented on a rotational basis through identified subunits. Using Geographical Information System (GIS), Dakota County would divide the park into ecological units and sub-units that are convenient to manage (e.g., prescribed burning units demarcated by existing and convenient hiking trails that serve as safe fire breaks). It is during the maintenance phase that the restoration plan would become part of the park's general operations and maintenance function. Along with this comes routine training and education of maintenance staff.

Restoration and Management Work Effort and Timeframes

In general, the actual stewardship work tasks are consistent between the remedial and maintenance phases. The primary distinction between the two phases lies in the intensity of the work involved to achieve a set of objectives, and the use of one restoration technique over that of another. For example, the initial removal of dense clusters of buckthorn in a given area may require substantial effort during the remedial phase. Under the maintenance phase, continued removal will still be necessary, but require substantially less effort. Figure 4.7 illustrates how the level of restoration effort lessens as the management plan moves from the remedial into the long term maintenance phase.

As figure 4.8 illustrates, the remedial phase can take up to five years to complete. This timeframe is highly dependent upon the magnitude of the work involved to complete restoration tasks and the resources committed to this effort. The maintenance phase begins once remedial work is completed and continues on indefinitely at a sustainable level.

Figure 4.7 – Work effort required between phases.

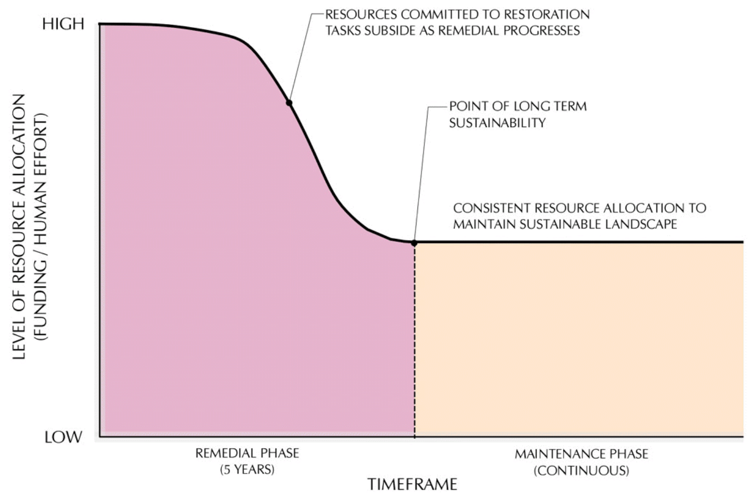
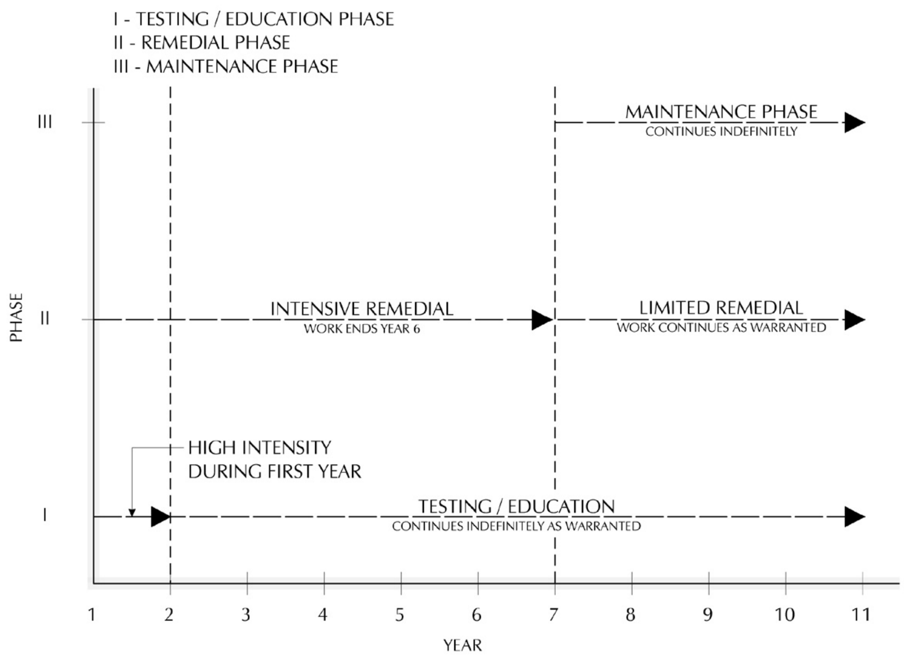


Figure 4.8 – Restoration and management timeframe.



Specialized Training

For many of the restoration tasks (e.g., prescribed burning, herbicide use, monitoring, and research) specialized training for project oversight and guidance are required well in advance of the dates for commencement of the stewardship program. Licensing or certification are often required for some of the restoration tasks. Personnel and volunteers involved in prescribed burning, brush control, monitoring, seed collection, etc., should receive training commensurate with the activity in which they would be involved. Training is especially important for those activities that may have risk and safety implications (e.g., prescribed burning), but also for monitoring, where an accurate assessment of the ecological performance of the ecological system to the restoration treatments is required.

Ecological Monitoring and Reporting

The process of ecological monitoring provides important and regular data on the effectiveness of the restoration program.

The process of ecological monitoring provides important and regular data on the effectiveness of the restoration program. Effectiveness is to be judged against the original (and new) goals and measurable objectives designed by the project. Goals are generally refined during project design phases and over time as project performance is measured.

Monitoring should use standard methods of measurement and provide a systematic record of important and key variables that directly or indirectly measure the ecological system and restoration performance. Monitoring for most variables can utilize study transects which can be permanently field marked. Repeating the sampling methods for vegetation would provide measures of the response of the vegetation community to restoration treatments. Photographic monitoring, including 35-millimeter color slide and color video coverage of the restoration treatment process and results, is useful. Permanently installed photographic stations can be identified and regularly visited during the course of the restoration process. This documentation, when coordinated with vegetation monitoring (also birds, insects, etc.), will be immensely useful in development of interpretive and educational materials.

The monitoring program should focus on measurement of the following variables:

- Effectiveness of management/restoration strategies on the structure and function of the ecological systems.
- Erosion control effectiveness and sedimentation rates.
- Attainment of the management/restoration goals and objectives.
- Public perception of the restoration program results.
- Visual conditions and changes that occur once restoration and management programs are implemented.

The monitoring program should be careful to focus on the most important parameters for ecological recover based on science, as opposed to what may be thought to be the most interesting. Also, monitoring programs should employ the simplest appropriate techniques to allow a wide variety of people with varying skills to participate. Periodically, a report should be prepared for the restoration program during the remedial phase. It should detail all tasks, labor, costs, and locations and dates of all management and restoration efforts undertaken. The report should also detail monitoring data collected to identify trends in the status and condition of the ecological variables. Public perception information, such as that generated in association with these demonstration projects, may best be reported in memorandum format (if this surveying is intermittent) or perhaps as a separate report if a standard (survey form) program for assessment of perception is implemented. Generally, a detailed technical analysis and summary of all the previous data should be completed every five years.

Overview of Restoration Techniques

The restoration and management plan requires implementing specific tasks to meet performance criteria and achieve improvements to the ecological systems within the park.

The restoration and management plan requires implementing specific tasks to meet performance criteria and achieve improvements to the ecological systems within the park. Forthcoming is an overview of specialized yet straight forward techniques used to carry out the specific restoration tasks. Of the techniques listed, prescribed burning is the single most useful and important management method required for restoration. The other restoration techniques and strategies are most often used to prepare a site for prescribed burning or as a means to reintroduce proper conditions and species into sites. It is important to underscore that these techniques are used as part of a well-thought out program that considers scientific practicality, costs, and safety.

Prescribed Burning

Prescribed burning is generally defined as:

> "*the highly controlled use of fire under optimal weather and environmental conditions to achieve specific ecological objectives*"

Wildfire and fires started by indigenous people and natural causes have played an important role in the evolution and maintenance of many biological systems throughout North America. It is now being realized just how essential the role of fire is in maintaining grasslands, wetlands, savannas, barrens, and numerous forest types. It is also now realized that fire suppression can result in gross changes in the aspect, appearance, and ecological functions of natural systems.

Fire suppression is often followed by a decline in the richness and diversity of native plants and animal species, increased litter, shading, phytotoxin build-up in substrates, decreased availability of essential nutrients and increased homogeneity in habitat structure and spatial heterogeneity. Reduced nutrient cycling and increasing domination by few species often results. In some ecosystems, shifts in wildlife and increases in shade tolerant and less flammable plant species accompany fire suppression.

Prescribed burning has been the primary prairie management tool, but only recently have efforts been made to use fire for the maintenance and restoration of other ecological systems. No other technique comes close to the impact that this naturally occurring phenomenon has on restoring and preserving natural ecological systems. It is a fundamental component of the restoration program to which there is no reasonable substitute. Conducted by trained personnel, prescribed burning has proven to be safe.

Weeding and Brushing

Preparation of the site so that prescribed burning can be introduced will be necessary in some locations given the extent to which invasive species have established themselves. Weeding and brushing are the primary techniques used where dense brush and little combustible fuel occurs. Manual reduction of existing dense shrub growths will be required to open these areas. Once open, prescribed burning can be used. This will be especially successful if native ground cover vegetation regeneration responds directly to the reintroduction of fire.

If the use of fire is hampered in areas with non-native cool season grasses, alternatives to consider to facilitate eventual use of fire include:

- Very careful and discriminate use of herbicides -- used where the evergreen growth of cool season grasses do not carry fire. Direct plant contact with a wick applicator and the herbicide *Rodeo* or *Roundup* have provided quick and safe initial control of the grasses.
- Low mowing of the grasses (0.5 to 1 inch height) -- can reduce green foliage and, after drying, litter can be used as fuel to carry a fire.

Herbicide is generally applied to cool season grasses after they have reached a height of 5-8 inches and display a new flush of green, actively growing foliage. It is applied at prescribed rates by trained and licensed field specialists. On larger pieces of property, wick applicators with adjustable boom heights are very useful for "wicking" plants.

Carefully overseeing the process is critical regardless of the method used.

Carefully overseeing the process is critical regardless of the method used. Although the herbicides used are incorporated within several hours after application and wick application (in contrast to spraying) involves a very small quantity of herbicide, the areas that are treated would be field labeled and guarded to manage human-use for the first couple of hours after application. The herbicides used, such as *Roundup*, have very low toxicity to humans and wildlife and will not present a threat when used properly.

Prescribed fire usually follows 5-15 days after the herbicide treatment or after the mowed grasses are dry enough to burn, which varies depending on weather conditions.

Seed Harvesting and Disbursement / Planting

Reintroduction of vegetative species will likely be required in areas where natural seed banks are lacking or in areas offering little opportunity for self-regeneration.

Reintroduction of vegetative species will likely be required in areas where natural seed banks are lacking or in areas offering little opportunity for self-regeneration. In these instances, it is recommended that reintroduction be generally limited to species that have historically occurred in the area.

In some cases, the use of non-native vegetative species may be warranted. An example of this is display gardens with plant species that may or may not have historic relevance. Another example is the use of short lived nonnative species (i.e., annual rye grass) which may assist in stabilizing badly eroding slopes. The key point is to understand the use of these plant species and their propensity for getting out of control, which is the case with buckthorn.

Plant propagation and the introduction of seeds and plants for local species should continue concurrently with other management and restoration strategies to achieve restoration objectives. Observations suggest some soil seed banks are present within the park and are vital to restoration programs. But to restore these and other areas, additional seeds from native species (either propagated and cultivated for seed production or wild picked seeds) should be gathered or produced in ample quantity and quality to enable prompt introduction during the early years of restoration.

For species that are no longer present in the area, appropriate locations should be identified for seed harvesting, propagation, cultivation and eventual introduction purposes. In as much as possible, seeds should come from areas close to the site of introduction. The bounds for collection for any introduction program are typically limited to the physiographic province (i.e., natural area division) of the recipient location.

Performance Criteria

Performance criteria establish a set of standards that are readily understandable to the lay person, yet achieve scientific objectives.

Performance criteria establish a set of standards that are readily understandable to the lay person, yet achieve scientific objectives. Realizing these performance benchmarks indicates that a desirable end is being achieved -- namely a sustainable landscape that brings the natural resources of the park closer to their pre-settlement qualities.

With strong public support and adequate resources, achieving a defined set of performance criteria is possible in this setting. The performance criteria should be developed as part of the initial phases of implementing the program and be based on scientific principles. Given the variability of the sites, performance criteria should be established for each site based on overall restoration objectives. Performance criteria should consider the following variables, at a minimum:

- Terrain
- Hydrology
- Soils
- Vegetation
- Animals
- Human use

Overview of Restoration Approach Associated with Each Ecological System

The restoration techniques listed above, as well as other appropriate practices, will be used to achieve specific improvements to natural resources within the park. The following table provides an overview of the restoration and management approaches as they relate to the ecological systems found within the park.

Overview of Restoration Approaches (Page 1 of 2)

Overview of Restoration Approaches to Various Ecological Systems

Ecological Type	Overview of Restoration and Management Approach
Forested Communities	The ground cover vegetation system in many, if not most, of the forested communities has or is collapsing and as each year passes is represented by fewer and fewer shade tolerant species. The combined influence of shading by young trees and European buckthorn have contributed to the decline of the native soil stabilizing vegetation. Ground cover vegetation in these stands varied from shade suppressed areas with an overstocked canopy to areas where dense invasion by buckthorn has occurred. Most oak savanna systems have experienced severe degradation where substantial erosion of the topsoil has occurred. Lack of oak regeneration and virtual dominance by older age classes of oaks is a major ecological concern. The dominant oaks are beginning to reach pathological maturity and will begin to degenerate rapidly. This is very problematic because older trees do not regenerate vegetatively. The impact of species like European buckthorn represent a major threat to soil stability in the forested communities. The lack of ground cover due to the excessive canopy closure tends to accelerate overland flow of water, resulting in poorer water quality in downstream areas. A precipitous decline in breeding bird use is also occurring with the decline in oak systems. Recent studies document the decline from over 28 native breeding bird species in quality oak systems to only 4 in serious degraded oak systems. Managing the invasive, non-native plant species and stabilizing the soils through the reintroduction of native species at the ground level are critical to restoring the forested communities. **Generalized Management /Restoration Approach:** 1) Herbicide treatment and manual reduction of undesirable introduced shrubs. 2) Removal of excessive litter and fallen trees to open up the understory and allow for prescribed burning to take place. 3) Prescribed burning on a regular (1-3 year) rotation. 4) Seeding with locally collected native plant seeds where native species seed banks are not present or do not respond to the above treatments. 5) Stimulation of oak and other hardwood species regeneration through the introduction of acorns and seedlings. 6) Monitoring and reporting of results
Prairie/Old Fields	A very high proportion of non-native grasses and other nonnative plants provide little opportunity for native ground cover species to establish or persist, or to flower and reproduce and thus many species have steadily declined. There is serious doubt that many native species, except those with long-lived soil propagules, will continue to survive under these conditions. Because non-native grasses and other aggressive perennial plant species dominate most areas that where perhaps once prairie, establishing and spreading desirable native ground cover species will not occur without management and restoration activity. **Generalized Management /Restoration Approach:** 1) Remove shrubs and stumps and other non-burnable vegetation. Herbicide treatment to reduce existing persistent non-native grasses. Mowing will also be necessary. 2) Prescribed burning on a regular (1-3 year) rotation. 3) Seeding with locally collected native plant seeds where native species seed banks are not present or do not respond to the above treatments. 4) Inter-seeding of native prairie grasses and forbs in existing old fields conducted by no-till drilling or scattered by hand after prescribed burning. Tillage is not desirable as this could stimulate weed species seeds. 5) Monitoring and reporting of results.

Overview of Restoration Approaches (Page 2 of 2)

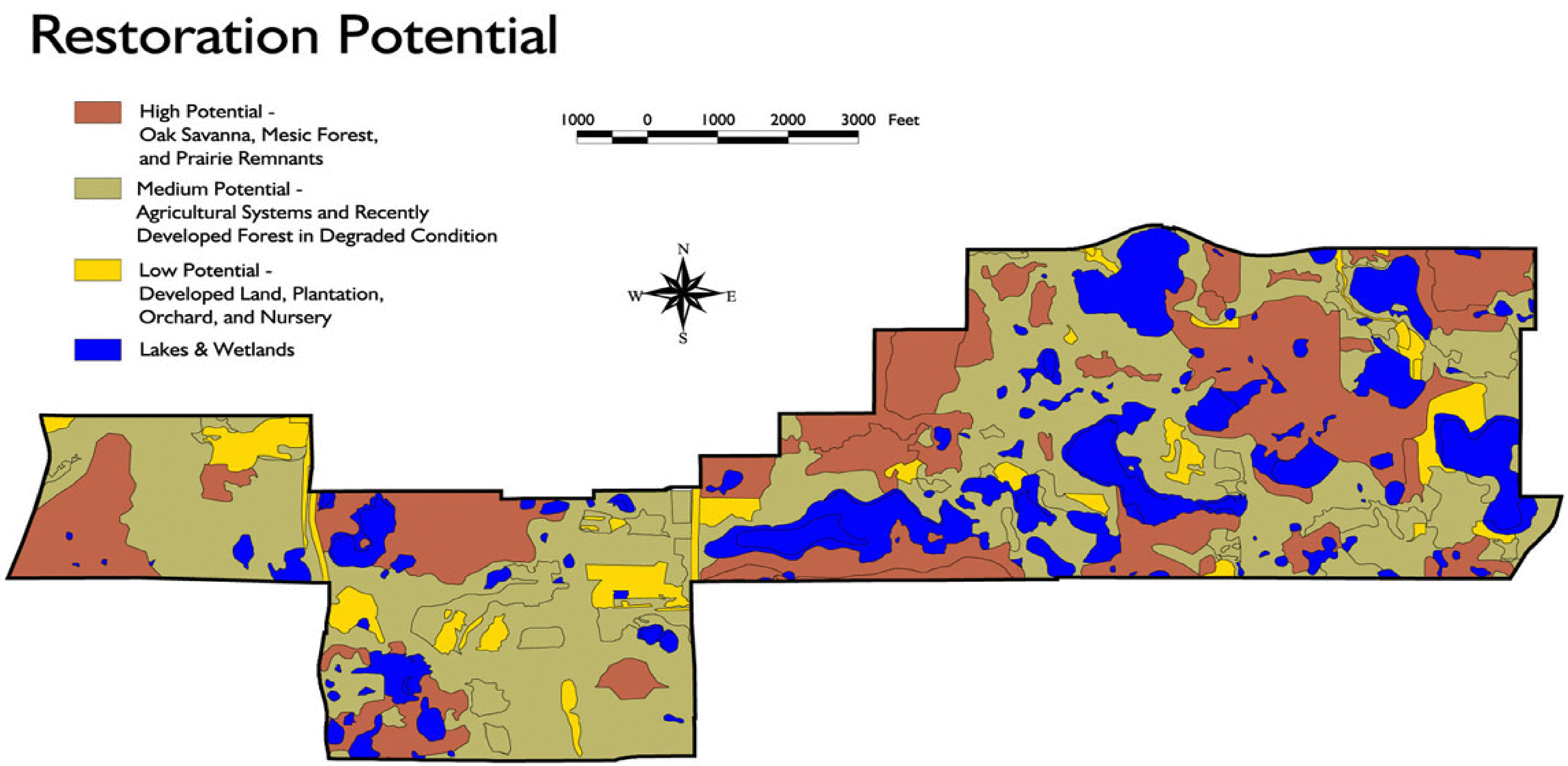
Overview of Restoration Approach to Various Ecological Systems

Ecological Type	Overview of Restoration and Management Approach
Wetlands	With respect to the wetlands that are not isolated in the park, serous signs of deterioration caused by excessive nutrient loading from urban stormwater systems and other sources have been found. Although not investigated in this study, the ecological changes observed suggest that the surface water chemistry and perhaps shallow/ground water chemistry have been significantly altered by the addition of high levels of macro-nutrients. Additional study of nutrient loading and remedies for this occurrence is recommended if a higher quality, more diverse wetland ecosystem is to be achieved. Wetlands that are more isolated show greater signs of native plant species, although these too need management to improve the ecological balance found there. **Generalized Management /Restoration Approach:** 1) Complete water resources management plan to determine the best approach to managing on-site hydrology and stormwater. 2) Implement water resources plan to attenuate on and off-site impacts to historic hydrologic systems where achievable. 3) Undertake stewardship program, starting with prescribed burning on a regular (1-3 year) rotation. 4) Spray herbicide treatment to reduce existing persistent non-native/undesirable grasses. 5) Seeding with locally collected native plant seeds or plugs where native species seed banks are not present or do not respond to the above treatments. 6) Monitoring and reporting of results. The first two steps listed are very important. Lacking an ecologically-sound resolution to the water resources management issues, restoring the plant communities in wetland areas will become a very challenging proposition.
Lakes and Ponds	Shoreline vegetation was shade suppressed similar to the ecotonal (transition zones between plant communities) areas along wetland margins. Sediment depositional areas in the lakes and ponds often show signs of invasion by aquatic plants. Field observation indicates that the lakes and ponds are fundamentally changing due to the upstream and upland ecological conditions previously defined as well as municipal storm water management practices. The capacity to restore the vegetation along the edge of the ponds and lakes and the aquatic systems within them is again linked to resolving the fundamental water resources issues facing the park.

Ecological Restoration Potential

While the potential for restoring the various ecological systems varies considerably across the park, and even within a given system, general conclusions can be made about restoring greater diversity and health to these systems. In doing so, the opportunities and challenges that are inherent with implementing a comprehensive stewardship program can be better understood. Figure 4.9 illustrates the restoration potential of the various ecological prototypes in very broad terms.

Figure 4.9 – Restoration potential of ecological systems within Lebanon Hills Regional Park.

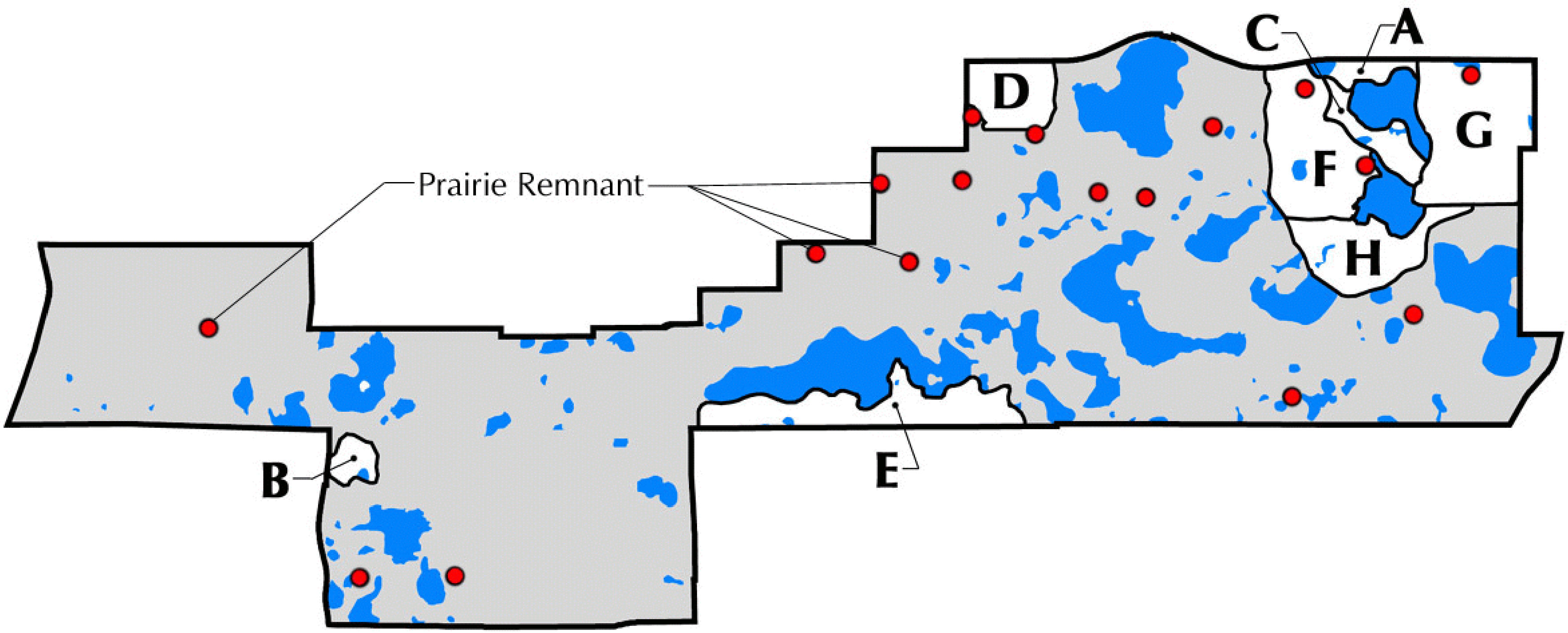


As the last figure illustrates, the higher ground and often less disturbed ecological systems tend to offer the highest potential for restoration. This is, however, a generalization and subject to extensive refinement as the stewardship program is implemented. What can be drawn from this is that implementation of the program will likely start with key threatened systems that offer the highest potential for success and, coincidentally, are the least costly to restore. As time moves on, success in restoring the higher potential systems will pave the way for taking on the more challenging ones that follow. Also note that implementation of the stewardship program would also take into consideration where it would be most visible to the park visitor. This is important in that the need to educate the public about the benefits of a healthy ecology will go a long way toward gaining continued support for the stewardship programs. In this context, restoring the areas near the Visitor Center first has considerable merit.

Priority Sites For Implementing the Stewardship Program

Although the stewardship program that will evolve from this master plan will define an implementation strategy based on a more thorough scientific analysis of the park, certain priority areas that were identified during the planning process warrant consideration for the first phase of implementation. Figure 4.10 highlights these areas, which is followed by a table that describes the stewardship need.

Figure 4.10 – Priority sites for implementing stewardship program.



Site	Description	Acreage	Priority Rationale
Dots	Prairie remnants (and other systems with native plant species.	Undefined.	Continuing to restore and manage important remnant of native species that are already identified in the park remains a high priority.
A	Groundwater recharge area west of McDonough Lake.	Upland forest community: 4.7 Upland prairie: 2.0 Wetland: 2.0	This is a critical ecological and water resource area in the park that is a top priority for restoration. Restoration would be lock-stepped with any improvements that would be made to this area as part of the water resources plan.
B	Existing RV campground area.	Mowed grasses: 8.7 Wetland: 2.0	Transitioning this area back to a native landscape is a high priority so that the campground better reflects the natural park setting.
C	Area adjacent to existing entrance road and Schulze Lake use area.	Upland forest community: 5.8 Upland prairie: 3.4 Wetland: 3.6	Restoring this area as part of the general facility upgrades is a priority. As an area that is "out the back door" of the visitor facility, restoration of this area offers high interpretive and educational potential.
D	Tamarack bog area.	Upland forest community20.5 Upland prairie: 3.6 Wetland: 4.0	Stewardship the bog and the surrounding upland area is important to preserving this unique natural feature.
E	Mesic forest/oak savanna area south of Jensen Lake.	Upland forest community50.0 Upland prairie: 1.0 Wetland: 1.0	Stewardship of this higher quality system is important to forestall continued decline. It will help reduce sediment loading into the lake caused by erosion of the topsoil on this steep slope.
F	Oak savanna system in degrading condition.	Upland forest community52.5 Upland prairie: 4.2 Wetland: 2.0	Restoring these areas is a priority to show a commitment to larger scale restoration starting with areas that are in a state of decline, offer higher restoration potential, and are near the center of the primary interpretive area within the park. Restoration of these areas will help establish critical scientific underpinnings that will be used to guide restoration activities in the rest of the park.
G	Upland prairie system in degraded condition.	Upland forest community44.3 Upland prairie: 9.5 Wetland: 3.0	
H	Oak savanna system in degraded condition.	Upland forest community38.4 Upland prairie: 1.0 Wetland: 2.0	

The areas defined in the table reflect general order of priority. However, a degree of flexibility in prioritizing these areas is still needed to allow for adjustments to be made in the field as the technical and scientific analysis is completed and restoration needs and complexities are better understood.

Water Resources Management Plan Review

The following provides a framework for evaluating the current water resources management plan to ensure consistency with the broader vision for the park.

The following hypotheses should be considered as an underpinning for making refinements to, and developing an implementation strategy for, the water resources management plan for the park.

As part of the planning process, the draft *Comprehensive Water Resources Management Plan* dated May of 2000 was reviewed to ensure that it was in alignment with the vision for the park that emerged from the master planning process. Key aspects of that vision that relate to water resources management include the desire to:

- Return the park's wetlands, ponds, and lakes to a more natural hydrologic state.
- Enhance water quality within the park's water bodies.
- Restore native vegetation in both upland and aquatic systems.
- Manage stormwater to reduce the propensity for unnatural fluctuations in water levels and flooding within and downstream of the park.

The following provides a framework for evaluating the current water resources management plan to ensure consistency with the broader vision for the park. By taking advantage of the technical strengths of that plan and modifying it to better respond to the vision articulated in this master plan, it is believed that a stronger, more viable, and ecological-sound approach to water management within the park will emerge.

An Ecologically-based Vision for Water Resources Management

To be consistent with the ecologically-based vision defined by this master plan, a number of visioning statements were prepared that relate to water resources management. These reflect what would be considered to be optimal outcomes of implementing a water resources plan that is ecologically-sound and responsive to the overall vision for the park. The following hypotheses should be considered as an underpinning for making refinements to, and developing an implementation strategy for, the water resources management plan for the park. The hypotheses include:

- Internal stormwater management needs of the park can be satisfied within its boundaries using both infiltration methods and restoration of native vegetation. This would help alleviate present flooding problems within and downstream of the park.
- A large percentage of the offsite stormwater runoff routed into the park can be treated and managed in the offsite watershed area where the runoff is produced using innovative offsite stormwater management methods. Designation of the park as a ecologically- sensitive area requiring special attention to stormwater runoff from offsite areas would also be implemented. A limited amount of offsite stormwater runoff treatment and volume/rate management (primarily from adjoining roadways) may need to be accomplished inside the park. This management would be located along the perimeter of the park to maintain the natural resources within its interior areas.
- No additional berming or dike construction within the internal lakes and wetlands is required and the existing constructed berms can be removed (with the possible exception of McDonough Lake and Marsh Lake).
- Many of the interior lakes and wetlands could be used as refugia for regionally declining game and non-game fish species. These "healthy" lake and wetland environments can be used for the propagation of regionally rare, special concern, and perhaps threatened native fish species that would be found in these types of habitats. In order to do so, the runoff from the watersheds must be of high quality and the wetland and lake water levels must be "biologically dynamic". This precludes the use of these wetlands and lakes for a predominant stormwater management function.

The stormwater treatment train is an approach to stormwater management that relies on passive, overland routing of runoff as opposed to storm sewers and other built structures.

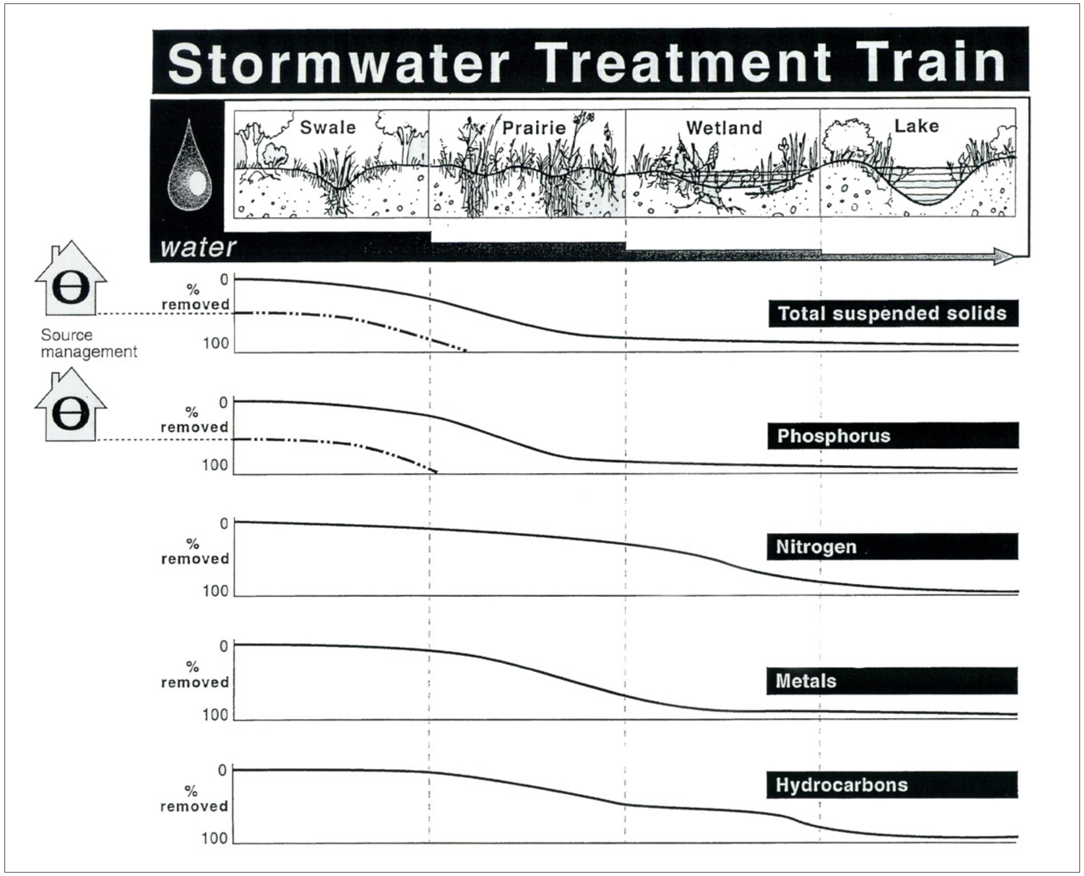
Stormwater Treatment Train as an Underpinning for an Ecologically-based Approach to Stormwater Management

The stormwater treatment train is an approach to stormwater management that relies on passive, overland routing of runoff as opposed to storm sewers and other built structures. This approach offers a couple of distinct advantages over conventional storm sewer systems:

1) Treatment of introduced contaminants picked up by runoff is removed at the initial stages of water flowage rather than being transported to downstream locations and accumulating in wetland and lake systems. This greatly reduces degradation to water quality and vegetative health in downstream systems.
2) Stormwater flow rates and volumes more closely emulate natural conditions. This greatly reduces unnatural fluctuations in water levels in downstream systems (wetlands and lakes) and therefore reduces impacts to the natural condition of water systems and vegetation.

Treatment train systems typically consist of a four key components, each of which perform in sequence to treat the water before it enters central wetlands and lakes. Initially, stormwater runoff from the built environment is routed into swales planted with native prairie and wetland vegetation. These swales convey runoff from built up areas into expansive prairies while also providing a modest amount of infiltration and settling of solids. The prairies are the second component of the treatment train, where they serve to slowly convey stormwater as diffuse overland flow to the wetland systems bordering wetlands or lakes. The prairies infiltrate a substantial portion of the annual surface runoff volume due to their very deep root system. They also provide additional solids settling and biological treatment. The wetlands are the third component of the treatment train system and provide both stormwater detention and biological treatment prior to runoff entering the lake. The final treatment component is the lake, which provides stormwater detention, additional solids settling and biological treatment. Figure 4.9 illustrates the treatment train system.

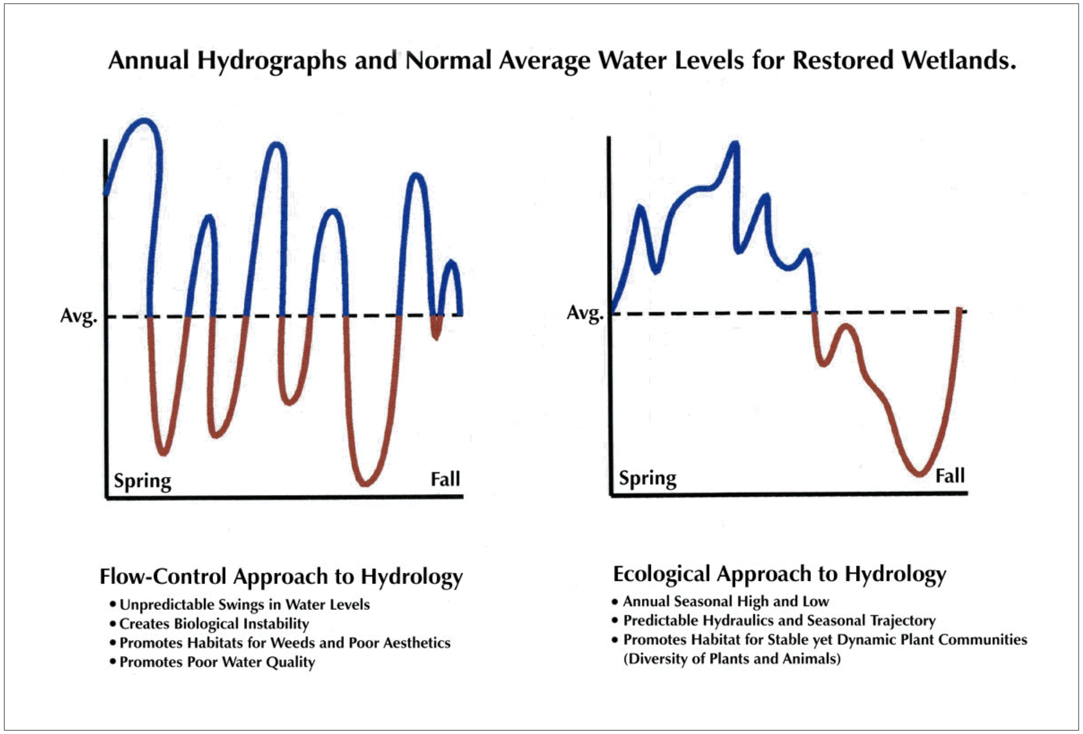
Figure 4.9– Stormwater Treatment Train. Source: Applied Ecological Services, Inc. (Trademarked).



With respect to stormwater flow rates and volumes, the use of a stormwater treatment train produces a much more natural hydrograph with lower peak flows and higher base flows relative to the hydrograph of a typical flow-control approach. Figure 4.10 is instructive in that it illustrates the difference between a flow-control and ecological approach to stormwater management. With certainly, the ecological approach to hydrology is desirable when ecological health is one of the principles being adhered to during development planning.

With respect to stormwater flow rates and volumes, the use of a stormwater treatment train produces a much more natural hydrograph with lower peak flows and higher base flows relative to the hydrograph of a typical flow-control approach.

Figure 4.10 – Annual hydrograph comparison.



An additional point about the treatment train approach to stormwater management is the potential it offers to minimize development dollars by avoiding the costs of putting in storm sewer systems and other structures when a more ecologically sound approach is workable.

The concept of the treatment train has particular application to Lebanon Hills in that it focuses on ecologically-based solutions to stormwater management, which is a sound philosophical underpinning that should drive key decisions related to the water resource management plan for the park.

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To realize the vision as stated and be congruent with the treatment train philosophy, a number of storm water management objectives would have to be incorporated into the Water Resources Plan.

Storm Water Management Objectives

To realize the vision as stated and to be congruent with the treatment train philosophy, a number of storm water management objectives would have to be incorporated into the Water Resources Plan. This would help achieve an optimal natural resource quality within the park boundaries and help minimize flooding to properties downstream of the park. The stormwater management plan would also relate to the ecological goals and restoration plan as defined previously in this section. The stormwater management objectives include:

- Offsite tributary areas should not contribute increased surface stormwater runoff water volume, rate or water quality impairments compared to undeveloped conditions within the park.
- Only high quality stormwater should enter the park from surrounding tributary areas.
- Only high quality stormwater should enter the park's water resource areas from on-site tributary areas (e.g. parking lots, and roadways). This runoff should be treated to provide effluent concentrations consistent with offsite runoff.
- Every stormwater management strategy should be tested to ensure it is compatible with the ecological restoration program and process, and the targeted ecological system health envisioned in the master plan.
- Safety of park users and downstream communities should be provided for frequent storm events and typical design storms including the 100-year event.
- The focus of stormwater management improvements should be in the upper tributary watersheds and should address quality, quantity and rate of stormwater runoff required to maintain the Park's integrity as a natural resource.
- Stormwater management improvements in the lower watershed should focus on extreme events.
- Stormwater improvements that require more engineered solutions should be located along the boundaries of the park and not in its internal areas.
- Restoration within the park should be the principle method used to maintain and enhance water quality (including sedimentation) and to reduce stormwater runoff volumes and rates.
- The natural drainage patterns should be restored within the internal area of the park and constructed dikes and most berms within the internal areas should be removed and eliminated
- Emphasis should be given to increasing the infiltration of treated stormwater runoff into the Jordan Sandstone and Franconia groundwater recharge areas.

Water Resources Management Focus Areas External to the Park

To add some context to the visioning points and objectives listed above, the following defines a number of potential strategies to address water resources issues that are external to the park. Each of these warrant greater consideration as the Water Resources Plan is refined. Note that these are only examples of contributing factors to the water resource issues facing the park and should not be construed to be an exhaustive evaluation of the opportunities worthy of consideration.

To add some context to the visioning points and objectives listed above, the following defines a number of potential strategies that warrant greater consideration as the Water Resources Plan is refined.

Minnesota Zoological Park: Water sources of concern include paved parking lots, building rooftops, and deteriorating plant communities that infiltrate less water than healthy systems. Potential treatment opportunities include:

- Parking lot reconstruction to incorporate current best management practices (BMPs), including detention, infiltration, sunken vegetated curb inlets, and infiltration trenches.
- Roof top BMPs for water management to include infiltration systems, rain gardens, ornamental landscapes with water features, etc.
- Savanna and prairie restorations throughout the Zoological Park are needed to restore prairies in existing old fields, and restore ground cover vegetation systems in the extant degraded oak savanna.

Since the Zoological Park has an educational role, it is an ideal location to focus on regional demonstration opportunities for visitors.

Golf Courses: Water sources of concern include paved parking, building rooftops, and greens and compacted lawn fairways. Nutrient loadings generated by lawn fertilization treatments is also of concern. Potential treatment opportunities include:

- Stormwater retention by integrating stormwater management with golf course ponds and integrating native vegetation buffers along pond edges to stabilize these edges and provide water quality buffering.
- Minimize the application of fertilizers and focus the timing of their use so that they are applied when plants are seasonally ready to assimilate them.
- Parking lot redevelopment and management to reduce and infiltrate runoff.
- Fairway restoration to native prairie plantings to reduce lawn maintenance, fertilizer use and runoff from these areas.
- Savanna restoration from existing degraded conditions to lush ground story vegetation that will reduce water yield (rather than the current virtually bare ground conditions found beneath the oak savannas).
- Wetland restoration and creation opportunities exist in many of the golf course locations.

Cherrier Property: Water sources of concern include runoff from the property's watershed that overflows the road on the south side of the park. This runoff will likely increase as the Cherrier site is developed. Potential treatment opportunities include:

- If this land is to be developed, the use of "conservation development" would be most suitable.
- Raising 120th Street may be required if this land is developed to hold back high flood waters and then release them in a manageable way.
- If the development is not provided with sanitary sewer, the opportunity to integrate wetland biofilters for management of septic leachate will be important.

Diamond "T" Horse Stable Area: Water sources of concern include the potential for this area to generate runoff that would affect the park from the newly developing lands to the north and from Pilot Knob Road. Currently, a small detention pond exists on this site, but there is an opportunity to substantially increase the use of this property to reduce road runoff into the park. Potential treatment opportunities include;

- Creating a larger detention basin with water quality treatment wetland biofilters.
- Wetland restoration and creating wetland biofilters .

Church on Pilot Knob Road: Water sources of concern include water discharges from the site (front lawn, building roof area, and parking lot) onto Pilot Knob Road. This runoff appears to enter the park and flow into Jensen Lake. Potential treatment opportunities include:

- Exploring on-site infiltration systems using innovative practices such as rain garden retrofits and large infiltration areas.
- On-site water detention/retention systems on the church property, including biofiltration wetlands and prairie vegetated retention areas.

Water Resources Management Focus Areas Internal to the Park

Although external factors are very important, solutions to the water resources issues facing the park also lie within the park.

Although external factors are very important, solutions to the water resources issues facing the park also lie within the park. The following defines a number of potential strategies to address water resources issues that are internal to the park and that would compliment strategies for external influences.

Schulze Lake Use Area: Water sources of concern include the entrance road west of McDonough Lake, which periodically floods and makes the entrance impassable. This entrance road is also across from an area previously identified as a high groundwater recharge zone. Also of concern is runoff from the large parking lot near the beach. Potential treatment opportunities include:

- Remove and relocate the road. This includes removing the old surface and sub-grade materials to reestablish this area for groundwater recharge into the Jordan/Franconian groundwater recharge area.
- Create a wetland biofilter for parking lot runoff.
- Create engineered infiltration systems for the large parking lot to relieve surface water runoff from this area into the nearby lakes.

Removal of Drainage Infrastructure from within the Park: Water sources of concern include the existing drainage infrastructure including culverts and dikes that surcharge water in ponds, wetlands, and lakes and upon occasion trails. Potential treatment opportunities include:

- Reestablish the natural outlets of the wetlands, ponds and lakes.
- Reestablish the natural outlets of wetlands, ponds, and lakes.
- Restore native vegetation to areas where water control infrastructure is removed.

Of those listed, addressing the Schulze Lake use area water resource issues offers some shorter term opportunities that would dovetail into the longer-term plan no matter what direction that plan might take.

Of those listed, addressing the Schulze Lake use area water resource issues offers some shorter term opportunities that would dovetail into the longer-term plan no matter what direction that plan might take. Note, however, that is a preliminary assessment that must be proved substantive through greater scientific and engineering evaluation.

Also of importance with respect to on-site opportunities is the role of the ecological stewardship program. By restoring the park's native landscape, greater stormwater infiltration will occur that in turn will reduce the propensity for excessive runoff and downstream flooding.

Conclusions Drawn from Evaluation of the Water Resources Plan

Based on the initial critical review of the Water Resources Plan, it appears that numerous opportunities exist to manage on and off-site stormwater in a more ecologically-sound manner that goes beyond what is provided for in the current plan.

Based on the initial critical review of the Water Resources Plan, it appears that numerous opportunities exist to manage on and off-site stormwater in a more ecologically-sound manner that goes beyond what is provided for in the current plan. Although the above listed vision, objectives, and specific opportunities have yet to be completely assessed and tested as to there validity, they do serve to underscore the need to reassess the findings of the current plan to determine if it is the best course to follow or if refinements are needed.

Whereas the above defines potential opportunities to consider and explore, it should not be construed as being exhaustive. Clearly, there are other stormwater management opportunities that have yet to be defined and are worthy of investigation. In the end, the water management issues in the park will be resolved by addressing many smaller contributing factors, rather than finding one simple solution to a perplexing problem. Through the use of alternative stormwater management systems, great ecological benefits could be derived that would improve water quality and reduce total volumes of stormwater that need to be "managed". Equally important, the cultural value of the park as a natural oasis would also be vastly enhanced.

Note also that this discussion should not be construed as a critical analysis on the Water Resources Plan. In fact, that plan offers great insights to the decisions that need to be made and defining if-then scenarios associated with water resource management. What this discussion does represent is a second look at a very important aspect of the park that affects its core values as a natural open space. Given the strong commonly held vision for this park, confirming or perhaps redirecting the Water Resources Plan prior to its implementation seems prudent and responsible.

Recommended Next Step

The recommended next step with respect to the Water Resources Plan is to continue the process of refining it to determine the validity of the what is hypothesized here. This should be completed and accepted by Dakota County prior to implementation of any of the major recommendations of the Water Resources Plan that may be subject to change.

Conclusions of the Ecological Stewardship Program and Water Resources Management

Implementation of the Ecological Stewardship Program and Water Resources Management Plan is fundamentally important to preserving this valuable and unique natural resource. Although human use issues will continue to be of interest to citizens of the region, these pale in comparison to the important decisions that need to be made to preserve the natural systems in this park for future generations to enjoy. Lacking a strong commitment to reverse the current ecological trends facing the park, its long-term prospects are much more suspect. Today is indeed the time to take action and begin the slow, but all important, process of long-term stewardship of this wonderful resource.